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PROTECTION OF THE QUALITY AND SUPPLY OF FRESHWATER RESOURCES: APPLICATION OF INTEGRATED APPROACHES TO THE DEVELOPMENT, MANAGEMENT AND USE OF WATER RESOURCES

Report of the Secretary-General of the Conference

INTRODUCTION

1. By its decision 1/21, the Preparatory Committee for the United Nations Conference on Environment and Development (UNCED) requested the Secretary-General of the Conference to submit to the Preparatory Committee at its second session a progress report with recommendations for action. 1/ This request was taken up by the Intersecretariat Group for Water Resources of the Administrative Committee on Co-ordination (ACC) at its eleventh session held at Geneva from 3 to 5 October 1990. The Group agreed actively to support the UNCED secretariat in the preparation of the progress report.

2. The report which follows was prepared by the UNCED secretariat on the basis of contributions from United Nations agencies. It covers a variety of environmental and development issues, including living freshwater resources, transboundary water bodies, integrated resource management, monitoring and assessment, integration of environmental and developmental factors, freshwater supply and quality, human resources needs and the required institutional capacities. The sequence of presentation as given in decision 1/21 has been slightly modified in order to give a coherent picture of the freshwater situation and its various aspects and linkages.

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3. The organizations of the United Nations system have noted the recommendations contained in paragraph 3 of decision 1/21 of the Preparatory Committee concerning the preparations for the International Conference on Water and the Environment. The conference will be hosted by the Government of Ireland in Dublin from 26 to 31 January 1992. It will be convened by the World Meteorological Organization (WMO) on behalf of the United Nations system of organizations and specialized agencies under the aegis of UNCED. As requested, the UNCED secretariat will follow the preparatory work closely and will report thereon to the Preparatory Committee at its third session.

4. The Preparatory Committee is asked to consider how the results of the Dublin Conference can best be utilized in the UNCED preparatory process, given the relatively short time-span between the two Conferences.

I. IMPORTANCE OF FRESHWATER FOR ENVIRONMENT AND DEVELOPMENT

A. Linkages between freshwater resources and other issues

5. Although freshwater represents only about 3 per cent of the water on the planet, it constitutes one of the primary life-supporting resources within the global ecosystem that will become an issue of increasing importance in most regions of the world in the period ahead. Water in rivers, lakes and underground is in permanent contact with other environmental compartments and is used in a variety of human activities, many of which would not be possible without a water supply of adequate quantity and quality. In turn, however, these activities produce contamination and this has led to severe deterioration of natural ecosystems. Seven intersectoral aspects are highlighted below which, in relation to United Nations General Assembly resolution 44/228, are of immediate relevance:

(a) The relationship between water and agriculture has two aspects: the availability of water and the use which is made of it. In developing countries, the crucial challenge will continue to be how to match limited availability, particularly in semi-arid and arid areas, with the pressing needs for food production. Expansion of agriculture through irrigation beyond the areas currently occupied by rainfed agriculture is the only possible remedy. The total area of land cultivated in this way is expected to increase significantly by the end of the century. However, improper irrigation techniques and overirrigation, besides causing significant water losses, have led to soil erosion and salinization and, in aquatic ecosystems, to eutrophication and water contamination by pesticides, herbicides and fertilizers. Agroindustry and agrochemicals have become principal sources of water pollution. New irrigation techniques, such as drip-feeders, or waste-water reuse make more economic use of water and should reduce environmental impacts;

(b) The removal of forests, which has been accelerating seriously, is one of the most severe human interferences with natural ecosystems and occurs in river basins all around the world. Current deforestation rates may exceed 20 million hectares per year, with profound effects upon river run-off and changes to the hydrological balance at the drainage basin level and beyond. In addition, the

accelerated erosion of fertile topsoil has led to nutrient leaching and downstream enrichment with increasing eutrophication of lakes and rivers. Higher sediment loads from rivers fill up reservoirs and make water treatment for public supply more difficult and costly. It is therefore of the utmost importance that rational systems of land use (avoiding monoculture) are adopted wherever possible. Removal of forests may, to some extent, be beneficial for water supplies in the middle latitudes, where evaporation is reduced and more water can run off to fill the reservoirs;

(c) Water is used in energy development for consumptive and non-consumptive purposes. The main form of non-consumptive water use is hydroelectric power production, which does not change the quantity of water available for subsequent uses but does sometimes modify the quality of the water. Consumptive use of water takes place, for example, in cooling towers, ponds and sprayers in steam-electric and oil refining plants. Nuclear power stations along rivers, such as the Rhine, use freshwater and, through thermal discharges, disturb the aquatic ecosystem. Cooling towers also influence the micro-climate in the vicinity. In developing countries, irrigation is a major consumer of energy because water has to be pumped and lifted to the irrigated fields. Energy costs are therefore a crucial factor in agricultural water use and a driving force in the search for more efficient irrigation techniques;

(d) The supply of water to human settlements in adequate quantities and of an acceptable quality has become a crucial factor accompanied by growing risks in developing countries, particularly in the emerging megacities. Water resources are normally insufficient at the point of use and long-distance transport of water is often required. Of all indirect human influences on the hydrological balance, urbanization has perhaps the most dramatic impact. The natural drainage area is replaced with impermeable surfaces (which cause more rapid run-off and flooding in downstream areas) and with sewerage networks (which cause modified and concentrated water and waste streams). The absence of sewage treatment in many cities in the developing world (and several in more developed countries) means that the discharge of large quantities of waste-water to rivers and lakes results in severe pollution. In the developing world more than 95 per cent of urban sewage is discharged into surface waters without treatment. This has led to a major build-up of synthetic organic chemicals, nutrients and pathogens in watercourses;

(e) Water consumption by industry in developing countries is still relatively small in comparison to that of agriculture. Industrial effluents are nevertheless a major problem because water pollution control is still either entirely lacking or is grossly inadequate. Untreated effluents from centres of rapid industrialization is a problem of particular severity throughout East Asia. Agro-industrial activities and processing of crops and animals release not only organic material but also chemicals such as heavy metals and synthetic organics. Mining is Latin America's biggest water pollution source, particularly in the Andean region. Accidental pollution, such as that arising through the transport of dangerous products, can cause serious downstream problems. Hazardous wastes are not yet adequately controlled in any developing country - nor in many developed countries - and may well constitute a chemical time bomb for vital groundwater sources in many areas;

(f) Close linkages exist between the atmosphere and the aquatic environment, principally through climate change impacts on the hydrological cycle and by long-range atmospheric transport of pollutants. The expected average increase in world temperature will probably have severe consequences, particularly for developing countries in the arid and semi-arid climatic belts. In the Sudano-Sahelian region, temperature increases could result in decreased precipitation, which in turn could lead to a 40 per cent to 70 per cent reduction in annual run-off. Regions already faced with chronic food shortages would therefore face even greater hardships which could be alleviated only through rapid progress in agricultural production technologies, biotechnology and efficient water resource management (including waste-water reuse). The problem of pollutant transport by air and the resultant acid rain is currently confined mainly to the industrialized countries, although it may become an increasing problem in the rapidly industrializing countries of East Asia and Latin America. Soils and surface waters, particularly lakes, are of varying vulnerability to acid precipitation;

(g) In terms of health impact and of human suffering, it is infectious diseases associated with water that affect the largest number of people and is of the most consequence for developing countries. About 5 million infants die every year of diarrhoeal diseases that are transmitted through water contaminated by human faeces. Behind these, vector-borne diseases associated with the aquatic environment exact a heavy annual toll through morbidity and mortality. In particular, the expansion of irrigation systems has led to a resurgence of schistosomiasis in Africa and South-East Asia. Today, as many as 200 million people in rural areas are affected. In some areas the natural composition of drinking water causes human disease. Fluorides in the Earth's crust in concentration areas such as the African rift valley and Central Asia are found at high levels in drinking water and can cause crippling disabilities including skeletal fluorosis. In China alone, some 40 million people are suffering from conditions caused by high-fluoride waters. Similarly, arsenic causes disease in some rural areas supplied with groundwater. These effects are virtually all avoidable given the availability of adequate resources.

B. Integration of environmental and developmental factors

6. Economic and social development is dependent on numerous factors, of which freshwater is one of the most essential. The role of freshwater in development is not isolated: it is a contributory factor to a whole set of natural, human and economic resources that are all needed for sustainable development. Water is required directly or indirectly in many development processes that have different demands for water in terms of quantity and quality. These uses in turn will have different effects on water quality. A potential conflict therefore exists between different development processes in terms of quality and quality demand on limited resources. In addition, there is potential conflict in terms of demand for water and influence on quality between human development and the natural environment. Ecosystems in particular have requirements for quality and quantity that may not always be compatible with human needs.

7. There are two complementary views of the environment in terms of water management. One is of the pristine ecosystem, which should be protected from human influence and which should be preserved for aesthetic or cultural reasons, a view that has gained a place in many national policies for water management. The second view, which is probably more important in terms of sustainable development, sees humans as an integral part of and influence on the environment, in which many human activities use natural environmental processes. Human use of the environment is therefore seen as an essential part of everyday life and an essential component in development. Integrated management of water resources therefore needs to take full account of the use and potential benefits of environmental processes in human activities so as to manage activities and resources with due consideration of environmental protection and sustainable development.

8. Water resources development can have damaging effects on the environment, either directly through physical, chemical or biological changes or indirectly by moving human populations to vulnerable environments. Dam projects, for example, may flood productive agricultural land and cause farmers to move to more marginal land, which has limited use and is prone to degradation. Alternatively, a dam project in a previously unexploited and fragile environment may attract unplanned human activity, leading in turn to environmental degradation. Irrigation projects may lead to problems with water-related diseases, although techniques for tackling such problems are becoming more sophisticated and effective. These examples serve to emphasize that not only should water resource managers be aware of the important positive role of the environment in water development but that planning and prediction are essential to avoid unwanted environmental side-effects.

9. General environmental quality is important in water resources development and, within exploited systems, the management and preservation of natural ecosystems for conservation reasons may be considered important for reasons of recreation (including tourism), aesthetics and social welfare. In recent years, increasing emphasis has been placed upon the conservation of certain environmental resources, free from unregulated human activity. In the final analysis, the need for and effectiveness of such conservation depends largely upon national policies, with development perhaps playing an important role in conservation. Conservation of natural resources in this way should be regarded as part of a larger programme of management of water resources in which environmental quality is a central consideration.

II. LIVING FRESHWATER RESOURCES

A. Use of resources

10. The freshwaters of the world are inhabited by numerous species of plants and animals, of which fish and shellfish form the basis of important capture and culture fisheries. In general, aquatic communities are noted for their diversity, particularly in tropical regions. Living aquatic resources constitute an integral part of the ecosystem. Consequently, the exploitation of resources, such as fish, can be sustained only on the basis of a supportive ecosystem. This entails the structure of the ecosystem being maintained within acceptable conditions, including

food webs that support the target species. Overexploitation would lead to lower genetic diversity and damage the population structure.

11. The reliance of many human uses of water upon natural systems and the conservation of the systems themselves necessitates an understanding of the capacity of aquatic ecosystems for recovery from damage and the tolerance of their biotas to resist the direct and indirect impact of activities. However, the application of integrated management strategies for freshwater resources that effectively combine ecological and environmental issues with socio-economic objectives is far from simple. For example, the sustainability of both inland fisheries and aquaculture depends on the maintenance of adequate ecological and environmental quality to ensure the survival not only of the target species but also of the complex communities that support them. Sound management of fisheries and aquaculture is thus closely linked with the maintenance and protection of biological and genetic diversity. Economic value should therefore be attached to all living aquatic resources concerned, whether they are the economically exploited or the non-commercial species.

B. Degradation of the aquatic environment

12. Degradation of the aquatic environment is linked to the change or destruction of the habitats of living resources. Nearly all rivers and many lakes of the temperate zones are already in a highly modified condition and those of the tropics are rapidly undergoing alteration. The main causes are pollution, deforestation, the construction of reservoirs, large-scale irrigation schemes and inappropriate agricultural practices. The resulting problems are threefold: alterations to water quality; alterations to the hydrological régime; and changes in the morphology of aquatic systems.

13. Industrial and mining pollutants not only alter water quality and threaten the survival of individual species, but many of the contaminants accumulate in the flesh of edible organisms with potential harmful effects for human consumers. Eutrophication through agricultural and urban discharges initially may favour productivity patterns in nutrient-impoverished waters, but it will eventually lead to the degradation of the aquatic system and unfavourable changes in the nature of the communities of aquatic organisms, owing to the lack of dissolved oxygen.

14. The quantity of water flowing in rivers and streams and the replacement rate of waters in reservoirs (the hydrological régime) are important factors in regulating the nature of the living aquatic communities. The construction of dams for power generation, drinking water, navigation and irrigation has led to substantial alterations in the quantity of discharge into river channels and the timing of this discharge. In many cases fish and other species, which were finely attuned to the arrival of regular flood pulses for their reproduction, have been unable to adjust to the altered régime.

15. The construction of dams and the canalization and levelling of river channels (altering the morphology of aquatic systems) have detached the floodplain and the accompanying low-lying wetlands from the river channel in many of the major river systems of the world. This tendency is continuing as needs for flood protection, navigation and land reclamation lead to further modification of aquatic systems. Such changes have far-reaching consequences on aquatic organisms within the river as in most areas of the world, but particularly in the tropics, where riverine communities have evolved to depend on the normal functioning of a river floodplain ecosystem for the completion of their life cycle.

16. The exploitation of living aquatic resources can also threaten sustainability. Inconsiderate fishing practices, such as overexploitation or use of inappropriate fishing gear, can alter fish community structures and diminish the value, stability and total yield from the fishery itself. In these situations fish communities tend to be forced in the direction of dominance by smaller and smaller species with progressive loss to the fishery of larger individuals. As these changes reflect those produced by eutrophication and other forms of environmental degradation, aquatic ecosystems, which are subject both to fisheries and intensive use for other human activities, become severely stressed and the survival of the community threatened.

17. Aquaculture also entails considerable risks to the aquatic environment. The recent trend in expanding the intensive culture of economically valuable species, such as salmon, has led to large-scale modification of local ecosystems, the replacement of native species and the loss of biodiversity, with demonstrated genetic consequences. The uncontrolled use of artificial feeding and fertilizers produces excessive enrichment of the aquatic environment and consequently eutrophication, deoxygenation and siltation. Furthermore the introduction of new species for aquaculture and for fisheries management has led to considerable changes in native fauna and to the introduction of disease organisms that have infected wild and cultured stocks.

C. Wetlands

18. Wetlands are not wastelands. On the contrary, they are highly valuable and important ecosystems that are all too often undervalued. They have a high biological diversity that not only constitutes a rich habitat for important populations of birds - many of them migratory - and other species, but can also serve as the basis for the integrated management of fisheries, aquaculture and agriculture, thus providing food and income for millions of people. A further very important potential use of wetlands is for pollution control and biological water treatment, since many wetland species have the ability to filter a wide variety of organic pollutants. Some aquatic plants also can absorb nutrients like nitrogen, phosphorous and potassium and metals like lead, cadmium, iron and zinc directly from the water. There is still a great lack of understanding of the ecological importance of inland wetlands and their potential value for human society and many have been drained or filled for agriculture, cattle ranching and urban expansion. They are also used as solid-waste dumps or are flooded by dams and reservoirs to provide for irrigation or hydropower, often at the expense of downstream ecosystems and fisheries.

D. International activities

19. A number of conventions and international agreements relating to the conservation of biological diversity are already in place, including the 1971 Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention); the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora; the World Heritage Convention; the 1979 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention); and the Convention on the Protection of European Wildlife and their Habitats (Bern Convention). An international convention for the conservation and utilization of biological diversity has also been proposed, integrating the institutional infrastructures for genetic resources within one system. Under such a convention, individual management plans would be developed for fisheries, wildlife, agriculture and other sectors.

20. In many ways, regional actions have proved to be more practical. The regional fishery bodies of FAO, some river basin commissions and some international fisheries societies have all contributed to international dialogue on the conservation and management of the living resources of inland waters. Much remains to be done in this direction, however, and such existing mechanisms should be strengthened and mobilized for the management of fisheries in international river and lake basins.

III. SUPPLY OF FRESHWATER IN ADEQUATE QUANTITY AND QUALITY

21. The total amount of freshwater available on the planet would be adequate to meet present and future needs but unfortunately there is considerable disparity in its geographical distribution. The costs involved in bringing water to the areas where it is most needed are often prohibitive and the quality of the water may not be suitable for desired uses. Adequate supplies of freshwater are affected by general factors in development such as escalating oil and energy prices, low economic productivity, lack of financial resources, population growth, droughts and political instability. In addition, other constraints act specifically upon the water sector, such as rapid urbanization, increasing industrial production and agro-industrial expansion, all of which lead to intense competition for limited water resources. Unfortunately, the availability of water is not the only limiting factor: access to the resource is hampered by technical and economic constraints, particularly under conditions of water shortage. This results not only in a general lack of water in adequate quantities but often in a lack of accessibility to water of adequate quality. It is predicted that many countries in arid climatic zones will face a major water crisis within the next decade and that up to a quarter of the world's reliable water supply will become unsafe for use.

A. Freshwater availability

22. Driven by the need to produce food for ever-increasing populations, agriculture has become the most demanding water user. In developing countries about 85 per cent of all water is utilized for irrigation systems, many of them

with dismal efficiency records. Worldwide, efficiency is only about 37 per cent, leaving a wide margin for improvement and water savings. The intensification of agricultural production and the excessive use of agrochemicals has led to pollution by pesticides, herbicides and various nutrients of many surface and groundwater bodies that receive agricultural run-off and drainage waters.

23. The world's groundwater resources are potentially huge, but excessive exploitation without corresponding natural replenishment (overpumping) has led to continual lowering of the water-table in many irrigation areas and underneath many urban areas, leading in turn to salinization and land subsidence. In coastal plains, saltwater intrusion renders water quality unfit for all vital uses. Groundwater - as a natural resource with both ecological and economic value - is of vital importance for sustaining life, health and the integrity of ecosystems. Anthropogenic impact could permanently impair underground water resources, with far-reaching and unpredictable implications for present and future generations. The Charter on Groundwater Management adopted by the Economic Commission for Europe in 1989 draws the attention of Governments and the public to the need for the sustainable use of groundwater and the protection of this vital resource against overexploitation and pollution, and thus seeks to provide planners and decision makers with appropriate policy instruments.

24. Developing countries are now frequently facing a situation where the increase in the rate at which industrial pollution problems are growing is greater than the rate at which effective control over traditional pollution sources can be achieved. Unaffordably high treatment costs only aggravate the situation, and lead to diminishing water availability as a result of quality impairment.

25. The water sector suffers from a general inability to translate the necessary policy priorities into action plans and functional assignments. All too frequently, the kind of managerial skills and institutional structures needed to develop and enforce effective administrative regulations and legal provisions are missing. Moreover, engineering approaches and construction programmes have tended to dominate operational, maintenance and organizational thinking. As a result, regional allocations of water resources that are in line with sustainable withdrawal limits and effective control of pollution sources remain a rare exception.

B. Drinking water supply

26. During the International Drinking Water Supply and Sanitation Decade, 1981-1990, strenuous efforts were made in the water sector to ensure that global water supply and sanitation coverage kept up with population growth. Although the provision of safe drinking water to rural populations has been much improved, the number of people lacking such services has increased in the cities. Low-income groups living in unplanned settlements on the urban fringe, making up 30 to 60 per cent of the urban dwellers, constitute the most deprived group. Poverty is at the root of the very limited access to safe drinking water. Unaffordable and inadequate services result in ill-health and in a significant proportion of time spent in collecting water. Women are most affected by this and their time and energy for other vital family tasks is much reduced.

27. The uncritical adoption of approaches and technology from industrialized countries has led to systems that are badly understood by the users and, as a result, inadequately utilized and not sustained on a long-term basis. Lack of operational skills and system maintenance has thus negated a considerable proportion of the investments made in construction during the Water Decade. The availability of financial resources for water supply and sanitation services continues to be a major obstacle in achieving adequate supplies of drinking water. Developing countries also face difficulties in effectively allocating or utilizing the funds that are made available, often because of institutional weaknesses.

IV. MONITORING AND ASSESSMENT OF FRESHWATER RESOURCES

28. Reliable information on current situations and the prediction of future trends are essential prerequisites for policy formulation, routine management and planning of freshwater resources. Monitoring of both water quantity and quality must be included in any system of water resources control to identify the amount, quality, movement, location and use of the water. This information can be utilized to provide assessments of the relationships of water with other environmental and human factors, thus providing a rational and scientific basis for management and planning. Planning is concerned with preparing for future trends and development of water resources. It requires reliable information on the current and past status of the resource and on the influences that have led to the current situation. In some countries, the lack of data makes the nature of the resource an unknown element and effective planning haphazard. Better legislation, co-ordination and integration, together with financial commitment, are basic requirements for water resources assessment.

29. Monitoring information is particularly important in the setting of water quality standards for pollution control. Effective regulation is dependent upon precise specification of permitted environmental standards. Standards are based upon acceptable effects and, without good information on the nature of the environment, no prediction of effects or setting of realistic standards is possible. Monitoring is also necessary to ensure compliance with standards. Monitoring networks require detailed planning and strong commitment for successful operation. The location of stations and the variables to be measured will be dictated by decisions on what information is needed and a clear identification of priorities. An integrated network will monitor quantity and quality at stations in freshwater and groundwater (in some countries such networks include terrestrial and air monitoring functions). Frequency of sampling is of great significance in identifying quality and quantity trends and patterns.

30. Experience has shown that most monitoring programmes in developing countries are of short duration and have infrequent sampling, using poor methods owing to significant problems with laboratories and analytical methods. There is often significant replication of laboratory facilities in different institutions and the data are frequently used only to quantify problems or to monitor performance rather than as part of a wider programme of environmental quality monitoring, assessment and resource management. In addition, there is frequently diversity of equipment and methodology, poor management of analytical instruments, a lack of skilled labour and inadequate analytical quality control.

31. After the collection and analysis of samples, data should normally be subject to quality assurance, which requires the setting of standard or harmonized measurement methods, lines of communication and identification of responsibility for database management. However, information and data gathered for specific projects are often poorly kept and organized. Information and data on an increasing range of subjects are needed as management interests encompass chemical use and discharge, water use and waste water discharge patterns, land use, climate, run-off and social conditions. The choice and management of data-processing systems requires skilled staff, financial commitment and a good communications and support infrastructure.

32. Assessment requires not only monitoring data but also information on influences on water quality, research information and local expertise on the characteristics of the systems. To be effective, modelling requires data in suitable forms and a good information exchange and co-operation system. In many cases, assessment has been limited to the water resource of interest but, with an increased emphasis on integrated management, assessment will need to take account of a whole range of influences, factors and possible effects to produce the necessary options for management.

33. The United Nations Enviropment Programme (UNEP), the World Health Organization (WHO), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Meteorological Organization (WMO) have established guidelines to assist countries in the establishment and operation of monitoring programmes of both water quantity and water quality (surface and groundwater) and data-processing systems. A global freshwater quality monitoring and assessment programme as well as a global run-off data centre are in operation.

V. INTEGRATED WATER RESOURCE MANAGEMENT

34. Freshwater is a limited resource for which there are multiple uses and multiple demands. The limited nature of the resource in terms of quantity and quality means that competition will arise between users. As stated above, demand for water and influences on its quality and quantity are not isolated factors but are dependent upon a wide variety of economic, social and natural processes. The management of water resources aims to avoid user conflict and to maintain sustainable use of the resource. In many situations, this is best done within the terms of reference of planning and policy which will give a framework for management decisions and prepare for future development.

35. Water resources need to be managed at the river basin level to take account of hydrological conditions. There are many examples of integrated river basin management, particularly for international rivers (see vi below).

A. Management and use of water resources

36. Development places numerous demands on water resources. It is often necessary to proceed on several fronts at once, recognizing that for the successful development of one sector, others must also be improved. Water resources are essential agents in the development of agriculture, industry, power generation, waste disposal, human health and other areas. The demands and influences on quality and the development of water resources in these areas are not independent and, for effective management of water and sustainable use and development, some degree of integrated management is indispensable.

37. In the past, management of water resources in developing countries has been beset by many problems, arising from factors such as rapid socio-economic change, a complex and poorly understood environment, inadequate information and data support and lack of skilled workers. A recent UNESCO report identified four main problem categories: (a) little consideration of upstream or downstream effects of use; (b) little consideration of social and environmental effects; (c) poorly planned allocation of water; and (d) lack of implementation. It is often suggested that these problems could be avoided through integrated management.

38. The main components for the establishment of an integrated management system include the following. First, the existence of political credibility and commitment, producing a basis for policy harmonization, administrative authority and conflict resolution. Second, organizational structures must be established with defined boundaries of responsibility, compatible objectives and the capacity for flexibility and change in the light of evaluation of progress. Third, processes and mechanisms for integrated management are needed, covering planning, pollution control, economic evaluation and enforcement. Finally, organizational culture and participant attitudes should support integrated management, ranging from ministerial support through inter-agency communication to staff training and recruitment policies.

39. The Economic Commission for Europe (ECE) promotes the ecosystems approach to water management. This approach aims at restoring and maintaining the chemical, physical and biological characteristics of the waters of the respective ecosystems as well as safeguarding the water supply, in terms of both quality and quantity, for various uses. It gives an integrated view of planning and management of the ecosystem, acknowledging the need for sustainable management of both the ecosystem components and the environment as a whole. The ecosystems approach covers, among other factors, pollution prevention and control, restoration of beneficial uses (such as fisheries) and degraded ecosystems, conservation and the health and welfare of catchment residents. Comprehensive ecosystems assessments, integrated environmental monitoring, forecasting and modelling, regulations, co-ordination of planning, communications and education all contribute to a strategy for providing the sustainable use of aquatic ecosystems.

B. Approaches to pollution control

40. Pollution control should be a part of any integrated management programme. Control of water quality should be one of the primary aims of management, to supply water of suitable quality in controlled quantities in a sustainable way and to protect the natural environment. The many users of water all have the potential to pollute water in different ways and control of this pollution requires a unified concept of water quality and integrated management policies. New approaches, such as the concept of integrated pollution control currently being introduced within the United Kingdom and involving an integrated system of control for pollution of the air, land and water, are also increasingly being developed.

41. There is increasing emphasis on preventive approaches to pollution control, in general through controlling entry of the pollutant to the water body or, in the case of irrigation or deforestation, encouraging or enforcing methods that do not pollute water. Control of sources may start with planning permits for land use and move on to control of access to water. Such control may use water quality standards or effluent standards and permits, the former requiring good hydrological and environmental information on which to base the standard. Direct intervention in the design and operation of production processes may be used, together with effluent charges, subsidies for control, compensation for damages and education. Land-based waste management and the processes for sewage and drinking-water treatment are also important in controlling pollution. More Governments and organizations are now classifying and controlling the use and availability of hazardous substances with specific reference to their behaviour and possible effects in the aquatic environment. For example, the application of the precautionary principle may prohibit any discharge or use of certain metals, industrial organic compounds and pesticides in association with water.

VI. TRANSBOUNDARY FRESHWATER RESOURCES

42. There are more than 200 international river basins in the world, and co-operation between countries sharing freshwater resources is a basic requirement in many areas for sustainable and equitable use. Rational management is therefore necessary to sustain the use of freshwater essential for economic development, human health and the conservation of natural resources. For some international freshwater resources, formal agreements have been made to regulate use. Agreements can apply to rivers, lakes or groundwater and also to uses of freshwater resources that affect the quality of receiving marine waters.

43. Earlier agreements were often made with reference to specific uses of single water bodies, such as navigation or hydroelectricity generation. Another approach has been for two countries to draw up a treaty covering the use of all of their shared water resources. This type of agreement exists between Canada and the United States of America, which have a Boundary Waters Treaty, operated through the International Joint Commission. One example of the Commission's role was the elaboration of the 1978 Great Lakes Quality Agreement, which aimed to control pollution from direct discharge of effluents, airborne contamination and diffuse run-off.

44. More recent agreements or treaties often apply to a particular river basin, lake or aquifer that crosses international boundaries. These agreements have a variety of structures, seeking to control different influences on water quality or quantity. The International Commission for the Protection of the Rhine against Pollution, comprising all States along the Rhine, aims to improve the water quality of the river through common principles of management, reduction of discharge of priority substances and co-ordination of management. Countries bordering the North Sea and those in the basins of rivers flowing into it also co-operate to reduce inputs of pollutants to the sea through the North Sea Conferences. This is one of a growing number of examples of how the management of marine water quality requires agreement on national policies for freshwater quality.

45. A Convention on the Protection and Use of Transboundary Watercourses and International Lakes is under elaboration within ECE. The Convention, which is expected to be ready for signature early in 1992, will address at both regional and subregional levels issues such as prevention, control and reduction of transboundary water pollution, water-quality criteria and objectives, monitoring and assessment, research and development, exchange of information and responsibility and liability with regard to transboundary water pollution. A Code of Conduct on Accidental Pollution of Transboundary Inland Waters was adopted by ECE in 1990. 1/ This Code provides guidance for the competent authorities in preventing and combating the accidental pollution of transboundary inland waters during the pre- and post-accident stages.

46. The United Nations International Law Commission (ILC) is in the process of drafting a framework Convention that lays down the basic rules of international law by which States should be guided in the utilization of shared watercourses. Such rules, which are limited to non-navigational uses of shared watercourses, are intended to supplement the lack of specific treaties or agreements in any particular case, or to guide States in the framing of such treaties and agreements.

47. Plans for the management of shared water resources in developing countries often cover a wider range of issues than water quality or quantity alone. Water resources are influenced by a whole range of agricultural, industrial, socio-economic, environmental and other variables and there may not always be existing agencies for regulation of these factors to allow effective management of water. This has led to the management of water quality and quantity as the basis for a whole range of related factors within river basin management. Examples are the Lake Chad basin, the Niger River basin, the Kagera River basin and - more recently - the Zambesi River basin. In South-East Asia, the Mekong Committee was formed in 1957 to tackle the problems inherent in river basin planning for one of the world's major international rivers. Its achievements to date represent a major success in international co-operation.

VII. HUMAN RESOURCES DEVELOPMENT FOR FRESHWATER MANAGEMENT

48. Human resources development begins with planning for long-term needs for skills as part of the overall planning process for water resources management. Finance, institutional development and user needs are all important at this stage.

Planning also needs to take account of projected development because development will change water use and demand for quantity and quality. Equally, the modification of existing practices in water management and use is required for development to take place. To be effective, therefore, water resources management and development need to proceed in step. Human resources development is an essential tool for this: the WHO Basic Strategy Document on Human Resources Development for the International Drinking Water Supply and Sanitation Decade defined human resources development as the supervision and skill development of every level of paid and unpaid staff member serving water supply and sanitation.

49. Human resources development is implemented by means of a hierarchical approach, according to the levels of staff involved. In the first instance, education and technical training are required to ensure that sufficient staff are being trained in relevant skills to meet current needs and projected demands. Training may take place on the job or in a more formal setting for management personnel to take into account, together with any necessary revision of job descriptions, career development and promotion. Human resources development also operates at the level of the user with community-planned, developed and operated schemes, taking account of the importance of certain social, cultural or economic groups in water use (particularly women). Support services in training and in human resources development evaluation and modification are important considerations in any programme.

50. Many national and international organizations are developing programmes for human resources development in water resources, ranging from domestic water supply and sanitation to large-scale irrigation projects. A survey of human resources development programmes in 1989 indicated that two thirds of the national agencies that provided information had training policies and 60 per cent operated human resources development plans. In general, training strengths were in the development of facilities and support for training, preparation of training aids and in the evaluation of learning whereas there were weaknesses in analysis of training needs and the development of multidisciplinary teams of instructors. Management strengths lay in preparation of performance-oriented job descriptions and the development of training policies but weaknesses were found in rationalizing organizational structures and in evaluating the beneficial effects of training. Planning was found to be the weakest area - human resources needs, levels of service required and the ability of the organization to pay skilled staff. UNESCO and WMO have published documents giving advice on suggested course contents and curricula for water-related education and training and have evaluated the contents of several existing courses.

51. The role of women in water use and management has been particularly emphasized during the last decade and their full involvement has been encouraged at all levels of policy formation, planning and implementation. The degree of success in promoting women's involvement has varied, but efforts are continuing. The growing stress on local responsibility, sustainability and community-managed systems made it essential that human resources development should take particular account of the potential role and needs of women. In the same way as human resources development has been tailored to women as a social group, so other socio-cultural groups must be recognized in the design and operation of human resources development

programmes. To this end, the United Nations Development Programme (UNDP) and the World Bank have co-operated in developing teaching materials for water resources and the Promotion of the Role of Women in Water and Environmental Sanitation Services (PROWWESS) programme.

52. FAO has developed a system of classification for different types of irrigation agriculture, based on different types of water supply, distribution and control, ownership, crop production, maintenance and technical assistance, including a human resources development element. It covers different types of farmer training and management involvement for different types of irrigation and proposes model job descriptions for the staff involved in irrigation projects and has been used successfully, for example, in Indonesia.

VIII. STRENGTHENING OF INSTITUTIONAL CAPACITIES

53. As pressures on freshwater resources increase as a result of population and developmental growth, the institutions concerned with the management of resources need to be able to operate as effectively as possible at the local, national, regional and international levels. The need for strengthening and restructuring institutional capacities has been most pronounced where programmes for integrated river basin management have been implemented - in such cases, existing institutions frequently need to be modified to work in a co-operative context. In some cases this may mean operating under a new supervisory management body, with different aims, priorities and financial structures. The difficulties of implementing such modifications should not be underestimated, especially when transboundary co-operation is planned.

54. Legislation is one of the most crucial elements of water resources development and management. It provides the basis for secondary legislation, policy formation, regulations and enforcement: without a good legislative framework, effective management and institutional operation are far more difficult. Legislation needs to take account of and make provision for integrated water resources management, community involvement and catchment protection. An enduring problem in many countries for multisectoral water management is the existence of traditional water rights, which may create difficulties in controlling the resource. The legal background to established rights is often complex, and water-related legislation may need to be specifically adapted to local conditions, social and cultural traditions and existing laws. Legislation and regulations will also need to cover abstraction and discharge permits, quality standards and waste-water reuse for agriculture, all of which will require institutional implementation.

55. Managerial and financial principles for effective institutions, starting with some degree of autonomy for management from government control, should aim to achieve efficiency of operation and ensure optimum use of resources. Consumer consultation and realistic assessments of willingness of users to pay provide valuable information for management. Managers of water resources also need a good knowledge of the financial structure of their operation and need to be prepared to make changes where necessary. For adequate finance, tariffs should be set at realistic levels to cover costs, service debts, meet cash needs and provide for

maintenance and future investment. Good financial management requires information on the structure of the supply system: number of users, unit cost and quantity of water supplied, billing and cash collection. Accounting needs to be audited, budgeting should become a formal part of management procedure and financial management should apply to all levels of organization, even to community-managed standpipes. The Government can provide support services and the framework for management and financial procedures.

56. As part of the International Drinking Water Supply and Sanitation Decade, material was produced on institutional development for water supply and sanitation, supporting the aims of self-sustaining and socially relevant programmes, which included community involvement and were linked to the various sectoral interests. In many cases, sanitation and water supply were not linked, agencies were too centralized, projects were not self-reliant or lacked community involvement and did not sufficiently address the needs and means of users. An outline for institutional development reviews was suggested that examined current resources and performance and future requirements, moving through a participatory process in the institution. This process consists of workshops, dialogue on changes and priorities, intervention and evaluation of change.

57. Although much still remains to be done in the field of technical and scientific information exchange, considerable progress has been made in recent years. Partly as a result of the International Drinking Water Supply and Sanitation Decade, technical information exchange is now encouraged and national centres have been established in many countries. The programme on the exchange and transfer of information aims to strengthen national information systems for water supply and sanitation. Various international agencies have set up parallel programmes to promote information exchange and dissemination in their sectors of interest, including a user-oriented water-related information system that first aims to make the user aware of the value of information, information sources and methods of retrieval. This is conducted through training and publicity for the user, information officers and librarians and the formation of national support centres that are co-ordinated on a regional or global basis.

IX. POTENTIAL AREAS FOR ACTION

58. In accordance with the request of the Preparatory Committee in its decision 1/21 for a progress report with recommendations for action, potential areas for action are identified below that may be considered by the Preparatory Committee. It is expected, however, that the forthcoming International Conference on Water and the Environment in Dublin will provide more comprehensive recommendations for future action. These will be reported to the Preparatory Committee in due course.

59. Based upon the present progress report, seven key areas requiring action are identified as follows:

(a) Environmentally sound development freshwater resources:

(i) The concept of human activity occurring within and relying upon the environment needs to become central to water resources management and development. Awareness of the role of the environment in human uses of water needs to be promoted vigorously at all levels of organization, ranging from politicians and managers to the general public. Its crucial role in sustainable socio-economic development cannot be overemphasized, particularly in water-scarce areas;

(ii) Freshwater availability on an equitable and adequate basis can be achieved only if this vital resource is no longer considered a free common good or a social service. Its economic value has to be taken into account when reallocating the sparse resource among competing users. To this end, a judicious balance of technical, organizational, managerial and legal measures is required, including administrative regulations and effective enforcement mechanisms;

(iii) Preservation of ecologically sensitive water resources should be regarded as a natural extension of intersectoral management of natural resources. Detailed information, data and management plans are essential for effective conservation, taking account of the likely effects of development in other areas in terms of environmental quality and human activities. In some cases it may be possible to unite preservation interests with controlled tourism, groundwater protection, erosion control or socio-cultural policies;

(b) Managing transboundary watercourses and international lakes:

(i) Existing national regulatory or policy bodies may be used to implement agreements on shared water resources but this is effective only in cases where good communication exists and conflict is unlikely to arise. In many cases, especially those involving several countries or many issues, a joint mechanism in the form of a central commission may need to be established. Such a commission may be a valuable agent for conflict resolution and compliance regulation, provided that Governments delegate suitable powers;

(ii) Developing an intercountry agreement on an international river basin requires that existing laws and institutions are adequately considered. Modifications to national law may be necessary, either to remove possible conflicts or to enhance the effectiveness of intercountry co-operation. A concurrent integrated basin development programme may need to address a wider range of water use issues;

(iii) Good communication is essential for effective co-operation in managing shared resources. This includes not only basic infrastructure such as telecommunications and roads but also harmonization of the routine aspects of management, monitoring and assessment. Similarly, planning needs to be performed for the entire river or lake basin and monitoring

in different areas for quantity and quality of surface and groundwaters should be harmonized;

(c) Control of water pollution:

(i) Substantive and far-reaching measures need to be taken to preserve the quality of water bodies and the physical integrity of aquatic ecosystems. Because of the high and often indispensable value of water for a range of human activity other than fisheries, there has been a tendency to ignore the needs of the flora and fauna. To this end, erosion control is a matter of priority to protect fisheries from siltation;

(ii) As part of water resources management, an integrated pollution control policy is indispensable. Ideally, this should be a low or non-waste policy, aiming to control pollution sources through land use policy, recycling and recovery, clean technology and substitution of hazardous substances and techniques. A cradle-to-grave management policy for hazardous substances should be planned, with clear identification of responsibilities. Economic tools should be developed for water pollution control which make the polluter pay for the necessary treatment and clean-up measures;

(iii) In terms of development, international and national bodies should continue to research and test appropriate techniques for pollution reduction and control, particularly with reference to urban wastewater and to diffuse sources such as agricultural run-off. International agencies should produce concrete proposals for technology transfer for pollution control. This entails that impartial advice be made available on equipment procurement, techniques and instruments. Operation and maintenance of pollution control equipment is considered a crucial follow-up activity.

(d) Safeguarding water supply. The Global Consultation on Safe Water and Sanitation for the 1990s, held at New Delhi in September 1990, recognized that drinking water supply is not simply a technical issue, but also a crucial component of social and economic development. To this end, the Consultation recommended the following four guiding principles:

(i) Protection of the environment and safeguarding of health through the integrated management of water resources and liquid and solid wastes;

(ii) Institutional reforms promoting an integrated approach and including changes in procedures, attitudes and behaviour and the full participation of women at all levels;

(iii) Community management of services, backed by measures to strengthen local institutions in implementing and sustaining water and sanitation programmes;

(iv) Sound financial practices, achieved through better management of existing assets, and widespread use of appropriate technologies.

These principles should guide developing countries in preparing specific national strategies for the use of freshwater resources. In addition, it was recommended that this New Delhi statement be brought to the attention of UNCED to emphasize the special importance of freshwater supply in environmental management;

(e) Use of living freshwater resources:

(i) Needs for further action should be oriented towards the maintenance of vital living aquatic resources, preserving their genetic variability as the basis for sustainable productive activities. Conservation of biodiversity for its intrinsic value and for its economic value should be equally considered. It can be achieved only through a range of improved management practices, many of which require international co-operation as well as national legislation;

(ii) Propagation and culture represent a very good opportunity for increasing fisheries resources and also for management integrated with agricultural practices to increase food supply, employment and income at the local and national levels. There is also a need to manage the preservation, processing, transport and marketing of fishing products in an integrated fashion.

(iii) Applied research is needed to improve culture-based fisheries management. This concept includes those that may be classified as aquaculture, intensive or extensive, as they depend on the annual release of young stock;

(e) Capacity-building for monitoring:

(i) Plans for water quality monitoring networks, where they do not already exist, should be drawn up by Governments for measuring both quantity and quality of surface and groundwaters. These plans should have regard to national priorities for water use and pollution law enforcement, information for planning and environmental assessment and protection;

(ii) National laboratories should work within an integrated network, including standard procedures and equipment, data handling, reporting and interpretation. Co-operation and communication should occur at all levels between national agencies and be encouraged through appropriate organizational structures. Data quality control and analytical quality assurance should be standard procedure;

(iii) Research is required on many water quality issues. Of particular urgency is the adaptation of monitoring techniques to tropical conditions; such methods require verification and research. Biological monitoring is particularly promising in this respect. Research is required for water quality model application and for the development of groundwater quality models.

(g) Strengthening institutional and manpower capacities. The capacity of developing countries for managing freshwater resources has to be reinforced through a dual-focus strategy, addressing institutional development and human resources development at the same time. This area for action is the most decisive one in improving the protection and rational use of freshwater resources. Some of the necessary support activities include:

(i) The preparation and implementation of legislation and regulations is one of the key tasks of Governments, especially with regard to the future effectiveness of the institutions concerned and where multisectoral and integrated management of water resources is planned. In support, comparative studies of legislation should be prepared, covering such subjects as water supply and sewerage and cultural influences on legislation for water use and the required enforcement mechanisms;

(ii) International agencies should support the need for development of management and financial capabilities for water resources through guidelines on specific issues in management and finance, such as economic tools and tariffs, cost control, planning and capital investment. Research with specific reference to developing countries for management and finance should be encouraged and relevant information disseminated;

(iii) Technical improvements must be planned with due consideration being given to social and cultural issues. The concept of appropriate technology should be integral to the management of water resources to encourage sustainable methods in financial and technical terms. National institutions should co-operate in efforts to standardize equipment;

(iv) Information exchange and availability need to be expanded at all levels through publicity, seminars and education. National and international information suppliers should address real needs and provide suitable information in the required format and language. International agencies should co-operate on database operations and encourage some uniformity in the ways in which information is made available by and through national organizations;

(v) The human resources requirements for freshwater resources management should be assessed on a national basis, taking account of existing and required personnel and skills. Subsequent training plans should be task-oriented and become a permanent part of the management and personnel structure. Technical and managerial skills must be a priority but local training courses for field workers and community-based operators must also be developed. Preparation of suitable training materials for all levels of skills is an important prerequisite;

(vi) Strategies for human resources development should be adapted to specific socio-cultural and linguistic groups. Special attention needs to be given to the role of women and the momentum and experience gained by Governments and United Nations agencies in this area during the IDWSSD must be maintained and developed.

60. It is important to bear in mind that the main constraints upon any action designed to tackle the problems identified in the present report are those imposed by the lack of adequate financial and human resources.

Notes

1/ E/ECE/1225.